Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Technology Transfer & Partnership Office

TOP3–00174

Ceramic Composite Test Methods and Property Models

Technology

NASA Glenn Research Center researchers have developed a number of specialized test methods and physics-based property models that support successful fabrication and application of high-temperature ceramic composite materials.

Test Methods for Ceramic Composites

Glenn researchers have developed a variety of specialized and simple tests for evaluation of the properties of constituent materials for high-temperature ceramic composite systems. These include mechanical tests to measure

- The temperature-dependent tensile strength, creep behavior, and rupture behavior of small-diameter ceramic fibers in various structural forms;
- The oxidative durability and interfacial shear behavior of fiber coatings within as-fabricated composites
- The tensile cracking and creep-rupture behavior of ceramic matrices within the composites.

These tests along with microstructural observations have been successfully used to analyze and improve the performance of state-of-the-art SiC/SiC ceramic composite materials [1].

Benefits of the test methods include

- Improved quality control of constituent materials and processes used in the fabrication of ceramic composite products
- Determination of the physical, chemical, and mechanical properties of constituent materials for composite property analysis throughout the various stages of fabrication and application of ceramic composite products

Property Models for Ceramic Composites

GRC researchers have developed physics-based property models for many of the key properties needed for successful application of high temperature ceramic matrix composites. These models are both analytically and empirically derived, and are based on a fundamental understanding of the roles of the key constituents within the composite microstructure, including fiber, fiber architecture, fiber coating, matrix (and its own constituents), and residual porosity. For state-of-the-art SiC/SiC composite systems [1], the models have demonstrated close prediction of such intrinsic composite properties as elastic modulus, stress distribution for matrix cracking, ultimate tensile strength, rupture behavior at high temperatures and low stresses, microstructural stability at high temperatures, and thermal conductivity. They have also been expanded to account for environmental effects on rupture behavior, both at intermediate and high temperatures.

Benefits of the property models include

- A better understanding of those factors that require enhanced quality control during fabrication of ceramic composite products
- Focused development and optimization of those constituent materials and processes that control the structural performance and service life of ceramic composite products
- Analysis of the mechanistic sources for failure of ceramic composite products

Commercial Applications

These developed test methods and property models will provide for optimization of production yield and performance of ceramic matrix composite components for aerospace, industrial, and military applications such as

- Engine hot-section components
- Heat exchangers
- Furnace components

Options for Commercialization

Glenn is very interested in seeking companies interested in either applying the testing methods and/or property models to their products and processes; or entering into collaborations for joint development.

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References

High-Performance Fiber-Reinforced SiC/SiC Composite Systems, Glenn Technology Opportunity Sheet, TOP3–00173.

Key Words

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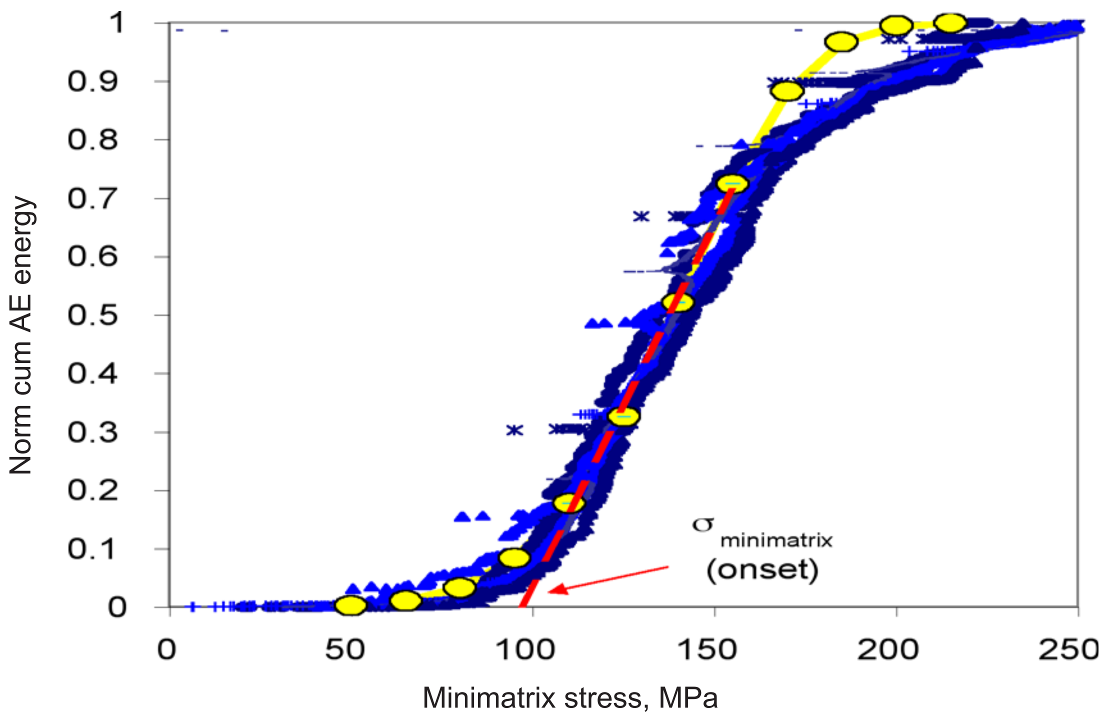

Figure 1.—Demonstration that the Glenn-developed model based on the concept of "mini-matrix stress" can yield a master curve for accurately predicting matrix cracking (as measured by AE) in 2D SiC/SiC panels formed from various constituents.